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Investigating the offshore wind turbine power generation in the U.S. - A case study in a life cycle perspective

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Picture Source: [1]

Background

The state of New York has set of target of 2,400 MW of offshore wind to be built by 2030 [2]. The present work is intended to act as an overview of cost related to this development. The main target is to compare the levelised cost of energy (LCOE) for 3 different rated-power offshore wind turbines.

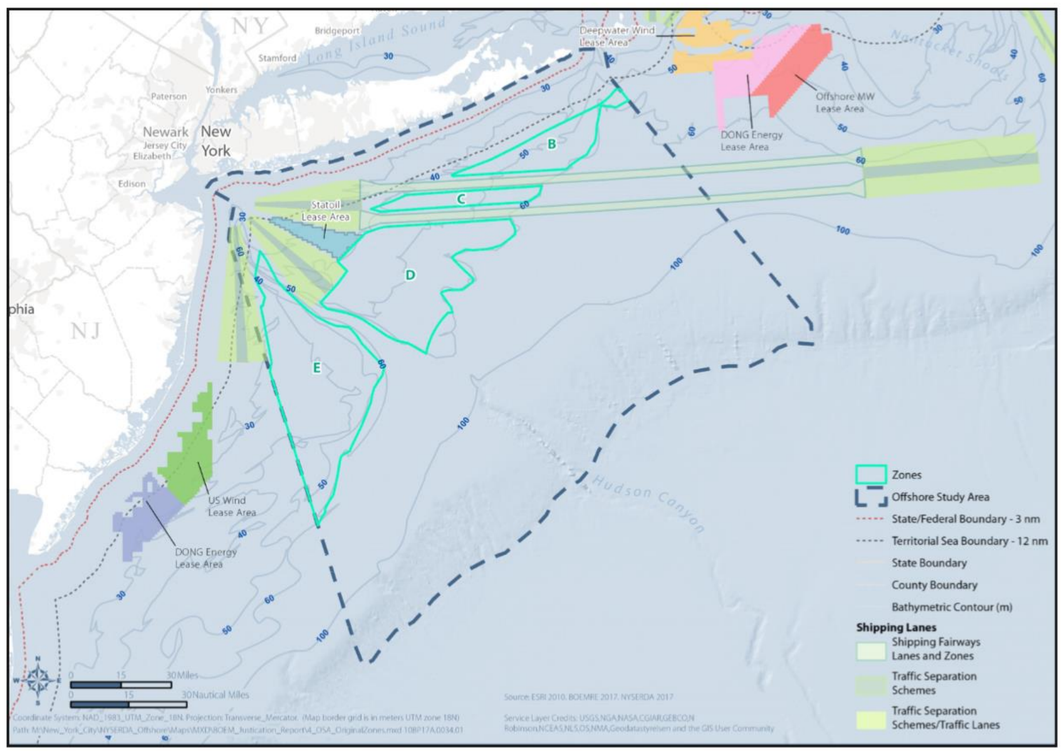


Fig. 1. Zones Considered for Potential Offshore Wind Development in the state of New York [2]

Levelised Cost of Energy (LCOE)

The LCOE analysis evaluates results from the Life Cycle Cost Assessment (LCCA) with regards to measure lifetime costs divided by energy production. The LCOE may be interpreted as the minimum unit price (discounted to present day prices) for which energy has to be sold in order to break even on the total investment [3].

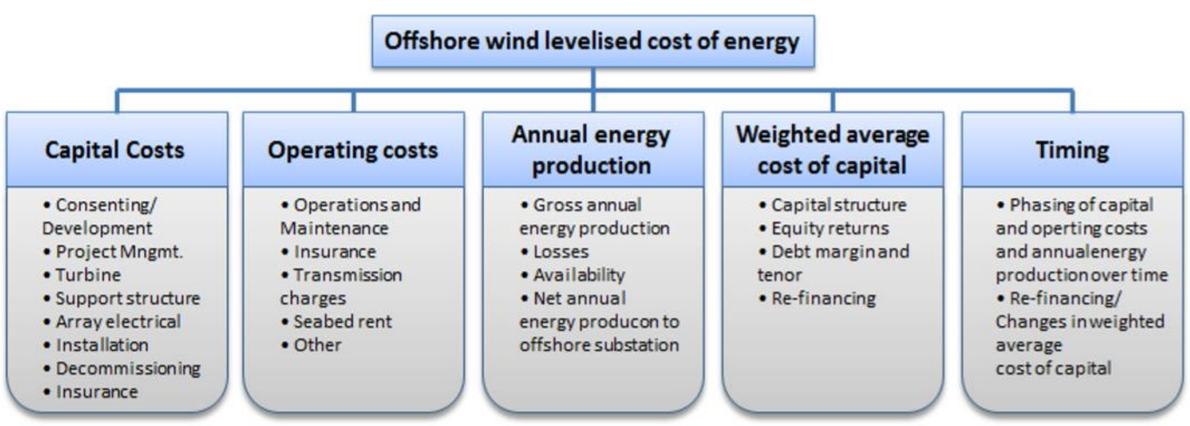
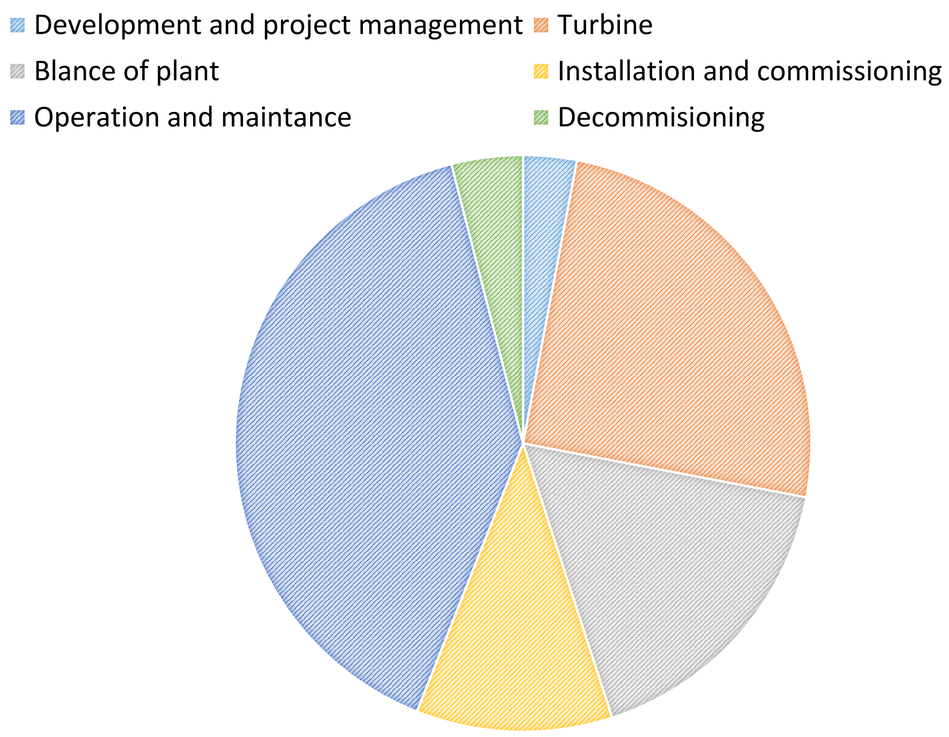


Fig. 2. Levelised cost of energy model for a single site in a specific year, derived from [4].

BREAKDOWN OF A 500 MW WIND FARM SPEND BY AREA [5]



Difference between Europe and U.S. Jones Act

Section 27 of the Merchant Marine Act is known as the Jones Act and deals with cabotage (coastwise trade) and requires that all goods transported by water between U.S. ports be carried on U.S.-flag ships, constructed in the United States, owned by U.S. citizens, and crewed by U.S. citizens and U.S. permanent residents [5].

The Jones Act factor raised by NREL [6] assumes that developers in the United States will be unable to utilize the European fleet of purpose-built wind power plant installation vessels. Therefore, it is likely that the most cost-effective solution is to utilize the existing fleet of capable U.S.-flagged vessels for installation activities rather than mobilizing a vessel from Europe [6].

Question 1 : Larger = Better ?

For a bottom-fixed offshore wind turbine farm, the wind farm area may still be a big issue. The present study is intended to investigate the LCOE per km^2 (area density). Three wind farms with different rated power turbines (3 MW, 5 MW, 8 MW with a monopile bottom structure design) are investigated in the present work. This may demonstrate that low rated power turbine may have a better performance in a more efficient way.

Question 2 : Seasonal Wind Profile Effect

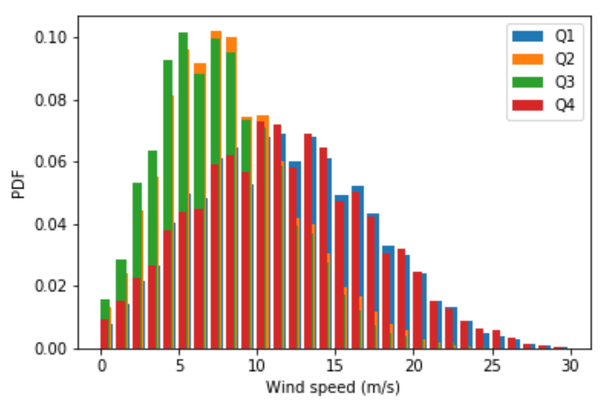


Fig. 3. Site measurement of wind speed

Question 3 : Environmental Impact (Future work)

Even the wind energy significant reduce the environmental impact compared with the fuel-based electricity generation, it has shown that wind farm still has environmental impacts majority resulting from the manufacture and installation processes [7]. Thus, it is essential to carry out a life cycle assessment for offshore wind farm developments.

Reference:
[1] https://www.windpowerengineering.com/business-news-projects/5-tips-for-offshore-wind-turbine-inspections-by-drone/ (access date: 14/1/2019).
[2] New York State Energy Research and Development Authority. Area for Consideration for the Potential Locating of Offshore Wind Energy Areas. New York State, U.S., 2017.
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[4] The Crown Estate. Offshore Wind Cost Reduction - Pathways Study. London: The Crown Estate. 2012.
[5] 46. U.S.C. § 50101 et seq. 2006.
[6] Beiter P, Musial W, Smith A, Kilcher L, Damiani R, Maness M, et al. A Spatial-Economic Cost Reduction Pathway Analysis for US Offshore Wind Energy Development from 2015–2030. National Renewable Energy Laboratory, September 2016.
[7] Pehnt, M. Dynamic life cycle assessment (LCA) of renewable energy technologies`, Renewable Energy, Vol. 31, No. 1, pp.55b71, 2006.

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